CASE REPORT

Thoracoscopic-Assisted Esophagectomy and Laparoscopic Gastric Pull-Up for Lye Injury

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ABSTRACT

Background: Acquired esophageal strictures in children are often the result of ingestion of caustic agents. We describe 2 children with severe esophageal strictures following lye ingestion, who successfully underwent esophagectomy and gastric pull-up utilizing combined thoracoscopic and laparoscopic techniques.

Methods: This was a retrospective chart analysis of both patients.

Case 1: A 17-year-old female, who ingested a lye-containing substance, which lead to the need for gastrostomy and esophageal dilatations, developed an esophageal stricture. Thoracoscopic esophagectomy, laparoscopic gastric conduit creation, pyloroplasty, gastric pull-up, and esophagogastric anastomosis was performed one year later. She was tolerating a regular diet for almost 4 years following esophageal replacement when she developed a gastric ulcer with gastrobronchial fistula that required open repair via a right thoracotomy. She has since recovered and resumed her regular diet.

Case 2: A 13-month-old female who ingested a lye-based cleaner underwent tracheostomy and gastrostomy on the day of injury, and esophageal dilatations beginning 1 month later. Despite dilatations, she developed severe strictures for which at age 21 months she underwent thoracoscopic esophageal mobilization, laparoscopic creation of gastric conduit, pyloroplasty, and esophagogastric anastomosis. A right thoracotomy was necessary to negotiate the conduit safely up to the neck. She is tolerating feeds and has not developed any complications for nearly 3 years following esophageal replacement.

Conclusions: Esophagectomy and gastric pull-up for esophageal lye injuries can be accomplished utilizing a combination of thoracoscopy and laparoscopy with excellent results. Long-term follow-up is necessary to manage potential complications in these patients.

Key Words: Laparoscopic gastric pull-up, Lye stricture, Thoracoscopic-assisted esophagectomy, Children, Gastrobronchial fistula.

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INTRODUCTION

Acquired esophageal stricture following lye ingestion in children is the most common indication for esophagectomy in children. Stricture dilatation is the primary method of management, but patients with strictures not amenable or responsive to dilatation require esophageal replacement. Failure of esophageal dilatation may be related to the severity of luminal narrowing or stricture length. Esophageal replacement with reinstitution of oral feeding has been shown to be advantageous in children.[1] Although delayed by many years in some cases, the potential for malignant transformation in the retained native esophagus has been reported following caustic injury.[2]

The technique as described for a combined thoracoscopic and laparoscopic approach in performing esophagectomy and replacement using a tubularized stomach conduit with a cervical esophagogastric anastomosis has been used extensively in our institution by our adult colleagues,[3] and we have previously described our use of this technique in a child with severe caustic esophageal stricture.[4] This report details the extended follow-up course for this patient as well as that of a second child who underwent a similar operation for caustic esophageal stricture formation.

METHODS

A retrospective chart review and follow-up was performed of 2 children who developed severe esophageal strictures following accidental ingestion of a lye-containing substance and required esophagectomy and esophageal replacement. The technique of thoracoscopic-as-

sisted esophagectomy and laparoscopic gastric conduit creation performed in both cases is described as follows with specific modifications performed in each case detailed later.

Operative Technique

With a double-lumen tube in place for single-lung ventilation, the patient is positioned in the left lateral decubitus position. The right lung is collapsed, and 4 thoracoscopic ports are inserted with the camera port (5 mm or 10 mm) placed at the seventh intercostal space, mid-axillary line. A second port is placed at the fifth intercostal space anteriorly for retraction of the lung and esophageal countertraction during dissection. Two additional 3-mm or 5-mm ports are placed, one at the ninth intercostal space posteriorly for the ultrasonic coagulating shears and another posterior to the tip of the scapula. The dissection begins in the mediastinal pleura overlying the esophagus, which is divided to expose the entire thoracic esophagus. Care is taken to avoid injury to the thoracic duct posteriorly and the airway medially throughout the dissection. A Penrose drain is placed around the esophagus to facilitate traction and exposure. The azygos vein is divided by using a 2.5-mm-endoscopic vascular stapler or hemoclips. The esophagus is mobilized and dissected circumferentially from the diaphragmatic reflection to the thoracic inlet. A Penrose drain around the dissected esophagus is positioned high up in the thoracic inlet to facilitate subsequent retrieval during the cervical approach. A single chest tube is inserted through the camera port, the lung is re-expanded, and the other port sites are closed.

The patient is then turned to the supine position and 6 abdominal ports are placed similar to our approach for laparoscopic Nissen fundoplication. The gastrostomy is taken down with the Endo-GIA stapler, the site is used for port placement, and the left lobe of the liver is retracted to expose the esophageal hiatus. The dissection begins with division of the gastro-hepatic ligament and exposure of the right crus of the diaphragm. Short gastric vessels are divided by using an ultrasonic device. The dissection continues along the greater curvature of the stomach, preserving the right gastroepiploic arcade. The stomach is retracted superiorly, to expose the left gastric artery and vein, which are divided using the Endo-GIA vascular stapler or hemoclips.

Next, a pyloroplasty is performed using ultrasonic shears and closed transversely using 2–0 sutures. A limited Kocher maneuver with mobilization of the duodenum and gastric antrum is then performed. The gastric tube, approximately 4 cm to 5 cm in diameter, is constructed by dividing the stomach with a 3.5-mm stapler from the direction of the lesser curvature towards the greater curvature and angle of His, preserving the right gastroepiploic vessels **(Figure 1)**. The gastric tube, now separated from the upper gastric pouch and distal esophagus, is attached to the esophageal and gastric specimen by using 2 sutures in preparation for pull-up into the neck.

The last step in the laparoscopic portion of the operation is the final dissection of the phrenoesophageal ligament, which opens the plane into the thoracic cavity. This step is completed last to minimize loss of pneumoperitoneum into the mediastinum. Partial division of the right and left crura at the apex is performed to widen the hiatus to prevent gastric tube outlet obstruction.

Attention is turned to the neck where a 3-cm to 4-cm horizontal neck incision is made just above the suprasternal notch, and the cervical esophagus is mobilized and exposed. Finger dissection is continued distally until the thoracic dissection plane is encountered and the Penrose drain around the esophagus is easily retrieved. The cervical esophagus is divided and the esophago-gastric specimen is pulled up through the neck wound. As traction is applied to the specimen in this manner, the esophagus and attached gastric tube are guided by laparoscopy into proper alignment into the mediastinum. The specimen is removed from the field through the neck. An anastomosis is performed between the esophagus and the gastric tube by using standard tech-

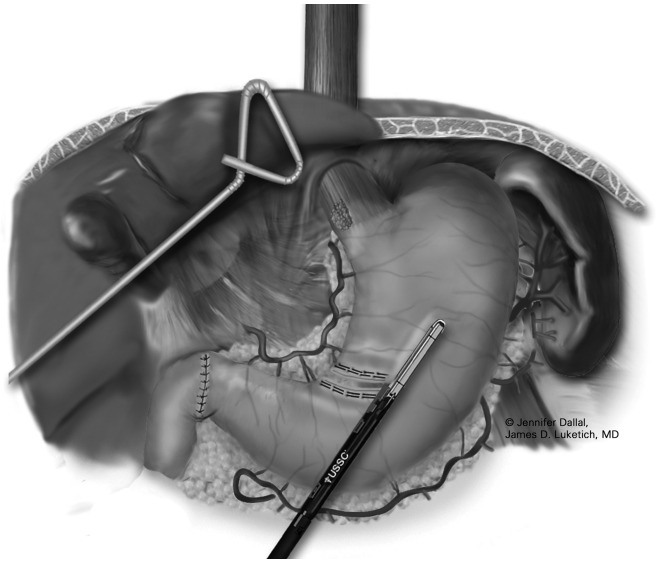

Figure 1. Creation of laparoscopic gastric conduit with blood supply based on the right gastroepiploic vessels. (Figure courtesy of J D Luketich, MD).

niques, and the gastric tube is sutured to the hiatus to prevent subsequent thoracic herniation **(Figure 2)**.

RESULTS

Case 1

A 17-year-old female who accidentally ingested a lye-containing substance underwent emergent endoscopy, bronchoscopy, and gastrostomy tube placement during her initial hospital admission. One month following ingestion, she had diffuse narrowing of the esophagus, and antegrade and retrograde dilatations were initiated. Over the next several months, she developed a long esophageal stricture and feeding intolerance **(Figure 3)**. One year after ingestion, right thoracoscopic esophagectomy, laparoscopic gastric conduit creation with pyloroplasty, gastric pull-up, and cervical esophagogastric anastomosis were performed. The operation lasted 7 hours, no perioperative complications occurred, and the patient was discharged on a soft diet on postoperative day 8. She was able to tolerate all oral feeds soon after her esophageal replacement operation, although this was in the form of several small meals per day. One year after thoracoscopic esophagectomy and laparoscopic gastric pull-up, she developed a food blockage at her esophagogastric anastomosis, which required endoscopic retrieval. No stricture was noted on esophagram study, nor has she ever required anastomotic dilatation. Routine yearly esophagrams revealed a patent esophagogastric anastomosis without stricture and free flow of contrast into the gastric conduit distally. Nearly 4 years after esophageal replacement, the

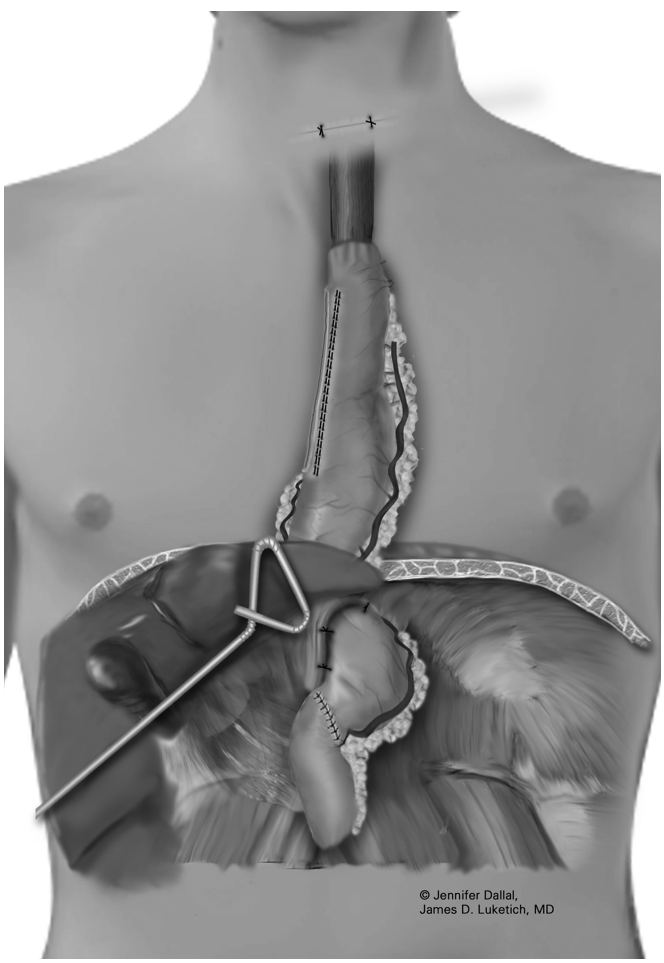

Figure 2. Appearance of completed laparoscopic, thoracoscopic gastric pull-up operation. (Figure courtesy of J D Luketich, MD).

Figure 3. Esophagram one year after caustic ingestion shows a long, narrow stricture from the carina to the distal esophagus.

patient developed a cough and feeding difficulty. Bronchoscopy revealed a fistula between her proximal right mainstem bronchus and the gastric conduit **(Figure 4)**. She had been noncompliant with her H-2 blocker medication for several months. Repair of the gastrobronchial fistula was performed via a right thoracotomy. Since this operation, her weight has been stable, and she is tolerating all oral feeds comprising a few small meals per day.

Case 2

A 13-month-old girl accidentally ingested a lye-based cleaner and underwent tracheostomy with open gastrostomy on the day of injury secondary to severe corrosive burns of her upper pharynx, epiglottis, and esophagus. An esophagram one month after ingestion revealed diffuse narrowing of the esophagus; therefore, retrograde esophageal dilatations were initiated. The tracheostomy was decannulated 2 months after injury. Despite frequent retrograde dilatations, the patient developed recalcitrant strictures **(Figure 5)**. Eight months after ingestion, she was not tolerating any oral feeds and developed aspiration pneumonia. Thus at age 21 months, right thoracoscopic esophageal mobilization, laparoscopic creation of a gastric conduit, pyloroplasty, and cervical esophagogastric anastomosis were performed. During the cervical dissection, an immense amount of fibrosis and inflammatory tissue was encountered likely due to the prior tracheostomy and dilatations. Due to the small size of her thoracic inlet, we opted to perform a right thoracotomy to negotiate the conduit safely up to the neck. It was felt that this

Figure 4. Bronchoscopic view of fistula from right mainstem bronchus into the gastric conduit.

Figure 5. Esophagram done 8 months after ingestion. Retrograde and antegrade esophageal dilatations reveal persistent strictures at the thoracic inlet and at the carina.

provided for less trauma to both the gastric conduit and recurrent laryngeal nerve. The operation lasted 13 hours, and the patient remained intubated for 7 days postoperatively. Her postoperative chest x-ray is shown in **Figure 6**. An esophagram on postoperative day 8 revealed no leak, and the patient was started on liquids. No postoperative complications occurred, except for prolonged mechanical ventilation, and upon discharge the patient was tolerating pureed feeds. Over 3 years after esophageal replacement, the patient is gaining weight appropriately and tolerating frequent small meals. She has not developed an esophagogastric anastomotic stricture or required any dilatations.

DISCUSSION

The progression of caustic esophageal injuries after unsuccessful dilatation has traditionally been managed utilizing esophagectomy with or without thoracotomy and either gastric conduit esophageal replacement or colonic interposition in children. The majority of the world's experience in esophageal replacement for caustic ingestion has been with colon interposition without utilizing minimally invasive techniques. The largest experience is that of Hamza et al[5] who reported over 850 cases of esophageal replacement for caustic injuries. In their series, gastric transposition was utilized in 75 patients. Supporters of using colon interposition have documented a higher stricture and anastomotic leak rate compared with that in the stomach, but dilatation has been very safe and effective in treating these strictures.[6] Spitz et al[7] have advocated gastric pull-up for esophageal replacement and report good long-term functional results. In their report, 23 children underwent gastric pull-up replacement for caustic injuries to the esophagus. Fortunately, in many countries, caustic injuries are infrequent events; however, it continues to be a significant problem requiring surgical intervention in certain cases.[4,8,9]

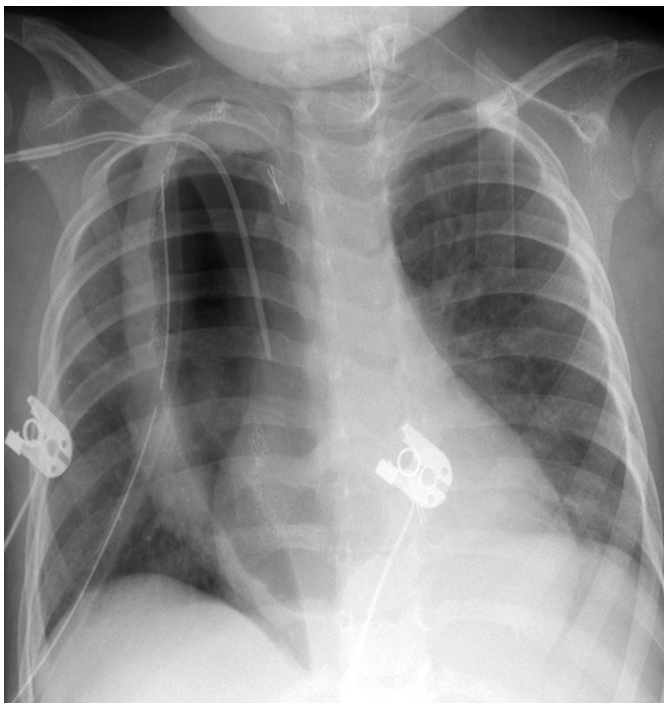

Figure 6. Postoperative chest radiograph after thoracoscopic-assisted esophagectomy and laparoscopic gastric pull-up demonstrates the gastric conduit occupying a large portion of the right hemithorax.

In adults, minimally invasive esophagectomy and gastric pull-up techniques for esophageal cancer and benign end-stage esophageal disorders have been achieved for large numbers of patients with improved quality of life scores postoperatively, comparable morbidity, and equal or lower mortality rates.[10,11] There has been little discussion about whether a minimally invasive approach is feasible for caustic injuries in children, because most of the controversy regarding esophageal replacement has centered on use of the stomach versus the colon as the interposition conduit.[12] Furthermore, the experience with minimally invasive esophagectomy in children is limited, particularly with respect to caustic injuries where the mediastinum can be significantly scarred. There have been isolated reports of minimally invasive gastric pull-up for infants with long-gap esophageal atresia where mediastinal scarring is not a hazard.[13] Cury et al[14] described 2 children who underwent thoracoscopic esophagectomy for benign esophageal strictures, but they then utilized a laparotomy to achieve the gastric conduit creation in both cases. We were the first to describe a totally minimally invasive esophagectomy and gastric pull-up in a child with a caustic esophageal injury.[4] The basis of this report is to describe the longer term follow-up for this initial patient in addition to the management and follow-up of a second child who sustained a similar injury. Our first case patient had initially recovered quite well from her operation aside from the single episode of food blockage and has not developed any complications or required any dilations or revisions for almost 4 years following her surgery. It is of paramount importance to follow these patients long-term because complications related to esophageal replacement often occur in a delayed fashion including anastomotic strictures (which may require dilatation or revision), conduit dilatation, and emptying prob-

lems.[15] Reports of the development of gastrobronchial fistulae in adults after gastric tube esophageal replacement have been sparse but have been linked to airway injury or inflammation,[16] erosion of a stomach staple into the airway,[17] and gastric tube ulcers.[18,19] Most of these gastrobronchial fistulae have been recognized within the first several days or weeks following the initial operation or associated with the immediate postoperative pull-up period. Our patient presented with a gastrobronchial fistula in a delayed fashion (almost 4 years following gastric pull-up), which may suggest that the tissue damage was related to gastric acid as proposed by Poje et al[20] who recommend the long-term use of antacid medications for these patients. The pathology specimen from gastrobronchial fistula repair from our first patient revealed a gastric wall with an ulcerated fistulous tract, serosal fibrosis, and adherent bronchus.

The initial operation for our second case patient was complicated by the difficult mediastinal dissection at the thoracic inlet, which was extremely challenging due to extensive inflammation likely from the previous dilatations and tracheostomy. The use of thoracoscopy for the initial esophageal mobilization was helpful in facilitating the eventual esophagectomy and gastric pull-up through a more limited thoracotomy incision to avoid injury to the gastric conduit or recurrent laryngeal nerve while negotiating the conduit safely up into the neck for anastomosis. Now more than 3 years after her esophageal replacement operation, the patient has recovered well, continues to tolerate all of her oral feeds, and has not developed any complications thus far. Performing gastric conduit creation laparoscopically proved to be very straightforward in both of our patients.

CONCLUSION

Based on our recent initial experience and follow-up of these 2 children with caustic esophageal injuries, we believe that a minimally invasive approach to esophagectomy and gastric pull-up, although very challenging technically, may be feasible and successful for this patient population. Due to the specific complications that may develop in these patients, long-term follow-up and continued use of antacid medications should be mandatory.

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